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Determinants of Auditor Expertise

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1. Introduction

In this study, we explore a view of expertise in which specific experiences and training create knowledge, and knowledge is combined with innate ability to perform specific audit tasks. Specifically, we test the extent to which we can explain cross-sectional variation in auditors' performance in several audit tasks using various types of knowledge and ability measures that have been identified in the psychology literature as important determinants of auditor expertise. We compare these results to the explanatory power of a simple measure of general audit experience. Our results indicate that, although more experienced auditors outperform less experienced auditors on average (and given our performance criteria), knowledge and innate ability provide a better explanation of variation in performance.

Part of the motivation for this paper is to distinguish between general experience and expertise in the performance of information-processing tasks. Early studies of human information processing in accounting examined the effect of experience on performance in audit tasks (see, for example, Ashton and Brown [1980], Hamilton and Wright [1982], and Messier [1983]). Implicit in this research is the notion that "... a primary determinant of improved expertise ... is experience" (Hamilton and Wright [1982, p. 757]). The reasoning behind this notion is that knowledge can be gained through experience and many audit tasks are knowl-

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edge-intensive, so that knowledge and performance should be linked. This idea was carried forward in later studies of auditor expertise in which subjects were classified as experts or novices on the basis of levels of general audit experience (see, for example, Frederick and Libby [1986], Butt [1988], and Marchant [1987]).

Although using experience to measure expertise has intuitive appeal, if we define expertise as task-specific superior performance (as suggested by Shanteau [1988], Wright [1988], Ashton [1989], and Davis and Solomon [1989]), there are also limitations to this approach. First, the evidence concerning the empirical relation between experience and performance is mixed. This is not surprising given that the theoretical link is equivocal, at best. For example, auditors with the same level of general audit experience are likely to have different specific experiences and training through which they acquire different knowledge (Libby [1989]); in addition, they may have different innate abilities which affect learning and performance in certain tasks. Second, using experience to indicate expertise allows no conceptual basis for differentiating among auditors with the same level of experience, although it is likely, for example, that some audit managers may be more expert than others at specific audit tasks.

Based on the results of this study, we suggest that researchers pay more attention to the criteria used to designate subjects as experts, either directly by the use of objective performance measures or indirectly by the use of well-specified measures of knowledge and ability.

In section 2 we review the expertise literature in accounting and other related areas and consider both the use of experience as an indicator of expertise and the relation of knowledge/ability to expertise. This review leads us to view auditor expertise in terms of the kinds of knowledge and ability required to perform well in specific audit tasks. The review is followed by a discussion of our research approach, the results of the study, and a discussion of the implications of our research.

2. *Literature Review*

2.1 EXPERIENCE AS A MEASURE OF EXPERTISE

Most studies of expertise have divided subjects into groups of experts and novices on the basis of years of experience or tenure-based titles (e.g., Murphy and Winkler [1977], in meteorology; Chi, Glaser, and Rees [1982], in physics; Oskamp [1965], in clinical psychology; Hamilton and Wright [1982], Messier [1983], and Frederick and Libby [1986], in auditing). Once subject groups were determined, these studies tested hypotheses about expertise-related differences in areas such as knowledge structures, performance, and problem-solving strategies. In only a few areas, such as chess and bridge, have performance-based measures been used to delineate subject groups, e.g., titles based on game-playing success (Chase and Simon [1973] and Charness [1979]).

Some of these studies indicate better average performance by experienced individuals but contain anomalies in the individual performance data. For example, in Murphy and Winkler [1977] the most accurate meteorologist had the least experience. Further, some studies indicate no difference in performance or differences in the wrong direction for experienced versus inexperienced individuals. Oskamp [1965] found no differences among psychologists, graduate students, and undergraduate students in accuracy of clinical diagnosis; Stael von Holstein [1971] found that research assistants were more accurate at temperature and precipitation predictions than practicing meteorologists with much more experience.

In accounting, Ashton and Brown [1980] and others found no differences between experienced and inexperienced auditors in consensus on internal control evaluation. Hamilton and Wright [1982] found a negative correlation between years of experience and consensus on internal control evaluation. Ashton [1989] found that months of general audit experience are not correlated with how accurately auditors judge the frequency of specific financial statement errors. These results may be due in part to the nature of the task and whether the knowledge required to perform these tasks is gained early in auditors' careers and decays over time (Bonner [1990]).

Results from both accounting and other fields imply that general experience is an incomplete measure of task-specific expertise. In accounting, in particular, different audit tasks require varying types of knowledge. Thus, researchers should specify the knowledge needed to complete tasks and not assume that all persons at a given level of experience equally possess task-specific knowledge.

2.2 THE ROLES OF KNOWLEDGE AND ABILITY IN EXPERT PERFORMANCE

Research in psychology has addressed the importance of various types of knowledge and ability for expertise. The following discussion focuses on three types of knowledge and one type of ability and suggests that not all types of knowledge are acquired equally by persons with a given amount of experience.

Extensive research has focused on expertise-related differences in *general domain knowledge*, that knowledge gained by most persons in a domain through instruction and experience. Chase and Simon [1973] found that chess masters have more general domain knowledge (knowledge of patterns of chess pieces) than novice players. Similar results have been found with Go players (Reitman [1976]) and bridge players (Engle and Bukstel [1978] and Charness [1979]). Chi et al. [1982] found that expert physicists have more knowledge of physics principles which allows them to be more accurate at solving physics problems. As Einhorn [1974] noted, general domain knowledge is necessary for expert performance.

Knowledge specifically related to a subspecialty within a general domain can be important to expert performance. This *subspecialty knowledge* is also acquired through formal instruction and experience, but only by persons in the subspecialty area. Joseph and Patel [1986] found that experienced physicians in a specialty area have more knowledge of relevant cues in that area than their experienced colleagues from a different specialty. In an intelligent tutoring system for medical diagnosis, Clancey [1984] separates subspecialty knowledge of diseases from general domain knowledge of diagnostic procedures. Voss et al. [1983] compared the problem-solving performance of expert political scientists who specialize in the Soviet Union with the performance of expert political scientists with different specialties. They found that non-Soviet experts provide less complete solutions than Soviet experts, probably due to their lack of subspecialty knowledge.

Additional knowledge, *world knowledge*, may be important for good performance in a particular domain but may not necessarily be gained through domain instruction or experience. This world knowledge is, instead, gained through individual life experiences and instruction and is not likely to be possessed equally by persons of equal experience. For example, Voss et al. [1983] noted that both domain-specific and world knowledge are important for political science problem solving, where world knowledge refers to knowledge of the physical and social world.

Although many studies (e.g., Chase and Simon [1973] and Chi et al. [1982]) have stressed specific types of knowledge as primary determinants of expertise, others have noted the potential importance of *general problem-solving ability*. This ability is likely to be partially innate and partially refined through experience in problem solving; again, not all persons with similar experience in a domain are likely to have similar problem-solving abilities. Lesgold [1984] notes that innate ability may be important to expertise, and Simon [1979] suggests that expertise requires both knowledge and general problem-solving ability. Hunter's review [1986] indicates that cognitive aptitude predicts job performance in a large number and variety of jobs. On the other hand, some studies have found that aptitude and ability are not associated with expertise. Walker [1987] found that domain knowledge is the primary determinant of subjects' learning about baseball; general aptitude has no effect. Ceci and Liker [1986] found that intelligence is not associated with expertise at handicapping harness races; rather, domain knowledge is the primary factor.

Depending on the task, expert performance may require one or more of these three types of knowledge and problem-solving ability. Because the different types of knowledge are acquired through different specific experiences and training and because problem-solving ability is partially innate, we expect knowledge and ability to explain more of the variation in performance than years of audit experience.

In auditing, several studies have examined expertise-related knowledge differences. Recall that all of these studies have delineated expert and novice groups on the basis of experience and that results regarding the relation between experience and performance are mixed. Further, most of these studies examined only *general domain knowledge*. Weber [1980] and Frederick [1989] found that experienced auditors could recall more internal controls than students. Libby and Frederick [1990] found that experienced auditors could generate more correct financial statement errors in a ratio analysis task than inexperienced auditors. Butt [1988] demonstrated that experienced auditors make better judgments about frequencies of financial statement errors than students.

Only two accounting studies have examined something other than general domain knowledge. Ashton [1989] found that industry experience (which would presumably create *subspecialty knowledge*) is positively correlated with the accuracy of judgments about relative frequencies of accounts containing errors in that industry. Marchant [1987] found that experienced auditors perform better at identifying possible errors in analytical review than inexperienced auditors, but the performance difference is not due to differences in analogical reasoning ability (part of *general problem-solving ability*).

The fact that these studies indicate experienced auditors have more knowledge supports the view that experience is a good predictor of knowledge and, therefore, of expertise. Most of these studies, however, have examined *general domain knowledge* which, by definition, is acquired over time by most persons in a domain. We would expect more experienced persons to have more general domain knowledge, but this finding does not rule out the above-stated hypothesis that knowledge and ability are better predictors of performance than years of experience.

2.3 DETERMINANTS OF AUDITOR EXPERTISE

As described above, there are at least three types of knowledge and one type of ability which seem to be potential determinants of expertise in various auditing tasks. First, audit experts must have general domain knowledge: a basic level of accounting and auditing knowledge, including knowledge of generally accepted accounting principles, generally accepted auditing standards, and the flow of transactions through an accounting system. As previously discussed, this general domain knowledge is acquired through formal training and through general experience as an auditor.

A second type of knowledge to be considered is subspecialty knowledge related to specialized industries or clients, acquired by persons who have experience with specific audit clients, with certain industries, and/or firm training in those specialized areas. Such knowledge is less likely to be acquired through general instruction or experience and, thus, is unlikely to be held by all auditors with a given level of experience.

A third type of knowledge which is likely to determine expertise in some auditing tasks is general business knowledge, such as an understanding of management incentives in a variety of contractual situations. This knowledge can be acquired through formal instruction and various personal experiences such as reading. Auditors both across and within experience levels are likely to differ with regard to this type of knowledge because of differences in mix of clients, personal interests in business, and so forth.

Another determinant of expertise is general problem-solving ability, which includes the ability to recognize relationships, interpret data, and reason analytically. Experienced auditors with the proper knowledge base who lack problem-solving ability will not be experts at some tasks. Likewise, auditors with problem-solving ability but without the proper knowledge base will perform poorly at some tasks. These dimensions of auditor expertise have been cited as important by a retired Arthur Andersen partner (Hall [1988]) and by a committee composed of the heads of what were formerly the Big Eight firms ("Perspectives on Education: Capabilities for Success in the Accounting Profession" [1989]).

Although we have posited the importance of several types of knowledge and ability in explaining expert performance, we have not discussed the conceptual structure of interrelationships among experience, ability, knowledge, and performance. We believe, for example, that experience combines with innate ability to develop knowledge, and that knowledge combines with ability to produce performance. Performance feedback further affects the development of knowledge. This conceptual structure is further complicated by a simultaneity problem, in that not only do specific experiences affect knowledge and performance, but performance also affects experience. That is, through promotion, retention, and assignment policies, auditors with expert performance are given the opportunity to gain additional experience and training; poor performers are reassigned or terminated.

While recognizing the complexity of the structure of expertise, we believe that it is premature to test these potential interrelationships. In this preliminary examination, our goal is to confirm the marginal benefit of including knowledge and ability variables in the study of expertise. To the extent that these dimensions of expertise are not correlated with years of audit experience, we suggest that years of experience will not be a reasonable predictor of audit expertise. Instead, the knowledge and abilities needed for a specific audit task will be better predictors. In the next section, we describe the approach taken to test our definition of auditor expertise.

3. Research Method

We developed four audit tasks with accuracy criteria to serve as performance-based measures of audit expertise and hypothesized the specific types of knowledge and ability necessary to perform accurately on each of the tasks. We then developed an instrument to measure knowledge and ability. Using practicing auditors, we tested the ability of the independent measures of knowledge and ability to predict variations in task performance.

In the remainder of this section, we discuss the development of the research materials, the hypotheses to be tested, and the details of the data collection.

3.1 AUDIT TASKS

All of the audit tasks were presented in the context of a continuing audit of a medium-sized, publicly traded manufacturing and distribution company. Background information, including a description of the company, financial statements, and notes, was adapted from the 1988 Annual Report and Form 10-K of Nashua Corporation.

Each task required the participant to assume that he or she was supervising the work of an assistant who had specific questions about the audit. The four tasks we developed were intended to vary as to types of knowledge and ability required, but we did not attempt *systematically* to vary these factors. First, a full factorial design would create a prohibitively lengthy instrument. Second, some combinations of knowledge and ability may not be required in any realistic audit task; for example, there are no audit tasks which would require only problem-solving ability. Third, we wished to include tasks similar to those studied in previous research for comparative purposes.[1] A description of each task and its requirements follows.

TASK 1 (*Internal Controls*): Given a specific weakness in the internal controls over accounts payable, list two financial statement errors that could occur and not be detected by the control system. Then list two substantive audit procedures that would be useful in detecting such errors.

This relatively simple task requires mostly *general domain knowledge*, i.e., understanding the kinds of controls typically found for accounts payable, financial statement errors that can result from weaknesses in those controls, and the best audit procedures to detect errors that might have gone undetected. Further, *subspecialty knowledge* gained from experience in the manufacturing industry may aid in understanding accounts payable controls.

TASK 2 (Ratio Analysis): Given a particular pattern of unexpected deviations in financial ratios, determine a single accounting error that could account for all of the unexpected changes in the ratios. List the accounts affected by the error; state whether the accounts are over- or

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[1] Note also that the correlations among performance measures for the four tasks, as shown in table 7, are very low, so that the tasks appear to require different types of knowledge and ability.

understated; and explain how errors in those accounts affect the related financial ratios.

This task, which was adapted from Bedard and Biggs [1989], requires *general domain knowledge* as follows: knowledge of the basic accounting model,[2] how ratios are computed, and how changes in specific accounts affect different ratios. Additional domain knowledge of certain error frequencies and the diagnosticities of various ratios would probably reduce the cognitive search required in this task. In addition, since the task involves computations and forward/backward reasoning, we believe *general problem-solving ability* would also be a determinant of performance. Finally, because the ratios involved are those for a manufacturing company, *subspecialty knowledge* gained through industry experience may also be helpful.

TASK 3 (Manipulation of Earnings): Given a particular pattern of errors in the timing of sales recognition, determine income effects for the two years involved. Assuming internal controls have been found to be effective in this area, speculate as to reasons for the apparent irregularities.

To perform accurately in this task, the subject must relate the income effects of the errors to a footnote in the financial statements describing a management compensation agreement. Such a process involves the analysis of data, problem identification, and information search that is guided by knowledge of management incentives and capabilities to misstate financial statements. Success in this task, then, requires *general domain knowledge*, *general problem-solving ability*, and *world knowledge.*

TASK 4 (Interest-Rate Swaps): Given details about an agreement between the client and another company to exchange fixed and floating rate payment, name the type of transaction and propose an acceptable accounting treatment for it.

This task requires *subspecialty knowledge* about financial instruments and, in particular, familiarity with interest-rate swaps.

3.2 KNOWLEDGE TEST

Having analyzed the requirements for successful completion of the four audit tasks, we developed a test to measure the required knowledge and ability. The components of this test relate to the previously described categories of general domain knowledge, subspecialty knowledge, world knowledge, and general problem-solving ability and represent the factors we believed to be most important for performance of the tasks. We also collected data on experience and training to proxy for specific knowledge that we were unable to include on our knowledge test due to time constraints. For example, we did not include in our knowledge test questions regarding manufacturing companies, although knowledge of manufacturing companies (as already discussed) is expected to be useful

[2] We assumed all accounting graduates would have this knowledge.

for some tasks. Instead, we asked subjects to indicate time spent auditing manufacturing companies. What follows are descriptions of the specific knowledge and ability tests and other data collected.

General Domain Knowledge. Task 1 required knowledge of controls and task 2 required knowledge relating to analytical procedures. Those two types of general domain knowledge were operationalized on the test as follows:

(1a) Accounting and Auditing—Controls (AUDCTL): We used ten multiple choice questions from recent CPA examinations and auditing textbooks (Guy and Alderman [1987] and Carmichael and Willingham [1989]). These questions, none of which was directly related to the requirement in task 1, covered knowledge of controls that should be in place in a variety of contexts, knowledge of errors that can result from control weaknesses, and knowledge about the ability of audit procedures to detect specific errors.

(1b) Self-Report of Ability to Evaluate Controls (ICEVAL): We asked subjects for this self-report on a five-point scale to proxy for any additional knowledge subjects might think they have with regard to this control task.

(2a) Accounting and Auditing—Analytical Procedures (AUDAPS): We used a combination of problems that we developed as well as problems from CPA exams, auditing textbooks, and prior research reports (Coakley and Loebbecke [1985] and Kinney, Salamon, and Uecker [1986]). These questions tested knowledge of how financial ratios are computed and how various errors affect ratios, the diagnosticity of ratios in specific instances, and the frequency of different types of errors in a manufacturing environment.

(2b) Self-Report of Ability in Ratio Analysis (RAEVAL): Again, we asked subjects for this rating on a five-point scale to proxy for any omitted knowledge in this area.

Subspecialty Knowledge. As discussed above, knowledge of the manufacturing industry may be useful in the performance of tasks 1 and 2, and knowledge of financial instruments should be a primary determinant of performance in task 4. These two types of subspecialty knowledge were operationalized as follows:

(1) Percentage of Audit Work in Manufacturing (MFG): Subjects were asked to indicate the percentage of their time spent auditing clients in the manufacturing industry.

(2a) Financial Instruments (FI): We tested the participant's knowledge of hedging transactions other than interest-rate swaps. Included were questions about the rights and responsibilities of the parties to a put contract and questions about the purposes and accounting for foreign currency forward exchange contracts.

(2b) Percentage of Audit Work in Financial Institutions (FIN): We also asked subjects to indicate this percentage based on the belief that financial institutions engage in a large number of interest-rate swaps.

(2c) Specific Experience or Training in Interest-Rate Swaps (IRS): Finally, we asked subjects to indicate the number of their clients who had engaged in interest-rate swaps and the number of hours of training they had had on accounting for interest-rate swaps. These questions were included because a knowledge test in this area would have been redundant with the task requirements.

World Knowledge. Task 3 required general business knowledge, operationalized as described below.

(1) General Business (GB): We developed a series of short-answer questions to measure knowledge of management incentives and current knowledge of the business environment, including questions about bond covenants, inherent risk factors, financial reporting policies, junk bonds, and recent Dow Jones activity.

(2) Specific Experience or Training in Client Manipulations of Earnings (MANIP): Again, we asked subjects to indicate the number of their clients who they thought had intentionally manipulated earnings and the number of hours of training they had had on this topic to proxy for any additional knowledge not covered by our primary test.

General Problem-Solving Ability (PSTOT): To measure general problem-solving ability, we used the elements of the 1987–4 Graduate Record Examination that were defined as involving problem solving. The total problem-solving score was the sum of three subsections of four questions each. These three subsections were analogical reasoning (the ability to recognize relationships and when these relationships are parallel), data interpretation (the ability to synthesize information and to select the appropriate information to answer the question), and analytical reasoning (the ability to analyze a given structure of relationships and to deduce new information from that structure).

In addition to the knowledge and ability variables discussed above, we also obtained information about general audit experience in months (*MOEXP*) and position within the firm (*TITLE*).

3.3 VALIDATION OF INSTRUMENTS

We did not validate the parts of the knowledge and ability test taken from textbooks, the CPA Exam, and the Graduate Record Exam. These questions comprised the problem-solving section and most of the two accounting and auditing sections. The remaining knowledge questions and all of the audit tasks were developed through discussions with our colleagues and with numerous audit partners and managers from two national accounting firms. The audit tasks and knowledge test were refined based on a pretest with 48 undergraduate auditing students and an interactive pretest with 4 experienced auditors. The auditors believed that the tasks were realistic and challenging. Finally, further refinements of the knowledge test were made based on a pretest with 36 graduate business students enrolled in an advanced auditing course.

3.4 RESEARCH HYPOTHESES

In our discussion to this point, we have asserted that expert performance in audit tasks requires, to varying degrees, certain general and task-specific kinds of knowledge and problem-solving ability. Our hypotheses are summarized below:

*H*1: General domain knowledge and subspecialty knowledge will provide incremental explanatory power over general experience for performance on the internal control task.

*H*2: General domain knowledge, subspecialty knowledge, and general problem-solving ability will provide incremental explanatory power over general experience for performance on the ratio analysis task.

*H*3: World knowledge and general problem-solving ability will provide incremental explanatory power over general experience for performance on the client manipulation task.

*H*4: Subspecialty knowledge will provide incremental explanatory power over general experience for the interest-rate swap task.

3.5 DATA COLLECTION

Participants in this study were 191 audit seniors and 62 senior managers from a single national accounting firm attending continuing education programs. The project was administered by the authors on five separate occasions. In addition, to provide a benchmark, we administered the study to 30 undergraduate auditing students with no public accounting experience.

The research materials were contained in three booklets. The first explained the nature of the project and contained a description of the company as well as financial statements with footnotes. The second contained the four tasks described above, and the third booklet contained the knowledge tests and an experience questionnaire. In all cases, the third booklet was distributed after completion and collection of the first two booklets.

Because of the length and complexity of the research materials and because of time constraints, we imposed time limits on each subsection of the booklets and periodically instructed subjects to move on to the next section. Anyone who finished a subsection early could go back to complete earlier sections or go ahead to the next section. Total time allowed for the completion of all materials was 1 hour and 45 minutes. Participants were in general highly motivated and worked diligently for the entire period.

Grading of the open-ended tasks and knowledge questions was performed jointly by the authors. Grading of multiple choice questions and the coding and entry of data were performed by a graduate research assistant. Data coding and entry were extensively audited by the authors. Of the 253 auditor participants, 14 were eliminated because of the failure to complete the experience questionnaire or, in the case of 2 subjects, because of frivolous responses. The data analysis, which is reported in the next section, was performed on a final sample of 60 senior managers with experience ranging from 63 to 123 months (mean = 95 months) and 179 seniors with experience ranging from 3 to 60 months (mean = 39 months). We report the student data separately.

4. *Results*

Our results will be viewed from two perspectives. First, we take the approach of most prior research in auditing expertise and compare the performance of senior managers, seniors, and students. Second, we present results for the auditors indicating the incremental explanatory power provided by knowledge and ability variables. As a benchmark, we present results for the students; these results indicate the importance of the knowledge and ability variables alone as predictors of task performance.

4.1 EXPERIENCE EFFECTS

Table 1 reports the performance and knowledge test scores for the audit seniors, senior managers, and students. Total scores for the audit tasks and knowledge and ability tests are not meaningful per se; however,

TABLE 1

Comparison of 60 Senior Managers, 179 Seniors, and 30 Students on Audit Task Performance, Knowledge, and Ability

Variable	Total Possible Score	Senior Managers		Seniors		Students	
		Mean	Range	Mean	Range	Mean	Range
Tasks:							
TASK 1	8	* 6.5†	0–8	# 5.9	0–8	4.8	0–8
TASK 2	15	* 4.3†	0–15	3.2	0–13	2.5	0–8
TASK 3	10	* 5.6	0–10	# 4.2	0–10	5.6	0–10
TASK 4	15	* 7.8†	0–15	4.3	0–15	2.8	0–8
Knowledge and Ability:							
FI	5	* 3.4†	0–5	2.3	0–5	2.3	0–4
GB	15	* 11.1†	2–15	9.5	1–15	8.8	4–13
AUDCTL	10	7.4†	4–10	# 7.2	3–10	4.6	1–8
AUDAPS	12	6.0†	1–10	# 6.3	1–12	5.0	1–8
PSTOT	12	* 7.0	2–11	# 5.5	1–12	7.4	3–11
Experience:							
MOEXP		95	63–156	39	3–60	0	—

TASK 1 = Internal controls
TASK 2 = Ratio analysis
TASK 3 = Manipulation of earnings
TASK 4 = Interest rate swap
MOEXP = Months of audit experience
FI = Financial instruments
GB = General business
AUDCTL = Accounting and auditing—controls
AUDAPS = Accounting and auditing—analytical procedures
PSTOT = Problem-solving ability
* = Senior managers significantly differ from seniors (two-tailed t-test, $p \leq 0.05$).
# = Seniors significantly differ from students.
† = Senior managers significantly differ from students.

as described below, the figures used for determining expert performance were not arbitrary. On average, the senior managers performed better than the seniors on all four audit tasks and scored significantly higher on tests of general business knowledge, financial instruments knowledge, and problem-solving ability. As we might expect, there was not much difference between these two groups with respect to general accounting and auditing knowledge. The biggest differences were in areas where we might expect audit experiences to matter, i.e., in more complex tasks and in knowledge acquired after graduation from college.

The senior managers also outperformed the students on three of the four tasks as well as on all knowledge tests; they scored similarly on the problem-solving ability test. Seniors outperformed the students on only the internal control task and performed worse on the client manipulation task. Their general domain knowledge was significantly greater than that of the students, and their problem-solving ability was not as good.

Although there are clearly experience effects in these comparisons of task performance and knowledge, it is not clear that experience is a good measure of expertise. In simple regressions of task performance on experience for the auditor groups only, the experience variable explains only .01 to .06 of the variance in the four tasks. Further, the mean scores mask individual differences. In table 2, we provide information about expert performance by individual seniors and senior managers. Expert performance in each audit task is defined as a score which we believe represents a substantially complete and correct response.[3] Although chi-square statistics again confirm the overall experience effect, there are a substantial number of seniors with expert performance and senior managers with nonexpert performance. These results lead us to look for more complete explanations of differences in performance.

4.2 MULTIPLE REGRESSION MODELS OF PERFORMANCE

To test other dimensions of expertise, we regressed performance in each of the four audit tasks on the various measures of specific knowledge and ability required for those tasks. These regressions include the data for auditors only because there were no experience or training data available for the students. Whereas the simple regression of performance on experience explained from 1% to 6% of the variance, the hypothesized models explain from 3% to 46% of the variation in performance. These regressions, reported in tables 3 through 6, support the measures of expertise contained in our hypotheses for three of the four audit tasks.

Only for task 1 (adjusted R^2 = .03) were we not able to explain a meaningful proportion of the variance in performance, probably because (as we saw in table 2) most participants were able to perform this task

[3] The cutoffs for determining expert performance were based on ex ante evaluations of the number of points in each task that would be required to exhibit substantially expert performance. Thus, it was possible that some tasks would have no experts.

TABLE 2

Chi-Square Tests of Relationship Between Experience Level and Percentage of Subjects Exhibiting Expert Performance for 60 Senior Managers, 179 Seniors, and 30 Students

Task	Percentage of Subjects with Expert Performance			Chi-Square Statistic	Significance
	Senior Managers	Seniors	Students		
Internal Controls	.85	.72	.47	14.62	.001
Ratio Analysis	.17	.04	.00	14.63	.001
Manipulation of Earnings	.38	.21	.43	11.57	.003
Interest-Rate Swap	.47	.26	.00	22.36	.000

TABLE 3

Regression of Internal Control Task Scores (TASK 1) on General Experience, General Domain Knowledge, and Subspecialty Knowledge for 239 Auditors

Variable	Beta	*T*-Statistic	Significance
MOEXP	.150	2.24	.026
MFG	.131	2.04	.042
ICEVAL	.096	1.48	.140
AUDCTL	.026	0.40	.690
CONSTANT		16.51	.000

Adjusted $R^2 = .03$.
For independent variable names and definitions, see table 7.

as experts. Of the remaining tasks, the general experience variable (*MOEXP*) is significant in only the regression for task 4, the interest-rate swap case. Even in this case, the explanatory power of the knowledge variables swamps the experience effect.

For tasks 2, 3, and 4, virtually all of the explained variance was accounted for by relevant knowledge variables and task-specific experience. In task 2, dealing with ratio analysis, performance was a function of problem-solving ability (*PSTOT*) and one measure of general domain knowledge (*AUDAPS*). In the client manipulation case, task 3, only world knowledge (*GB*) was significant. In task 4, significant explanatory variables included the proxies for subspecialty knowledge indicated by number of audit clients who engaged in swaps or have had firm training on interest-rate swaps (*IRS*), experience with financial institutions (*FIN*), the financial instruments knowledge (*FI*) score, and general experience (*MOEXP*).

4.3 CORRELATIONS AMONG INDEPENDENT VARIABLES

The Pearson correlation matrix in table 7 indicates that several of the independent variables are significantly correlated. We examined the impact of these intercorrelations in two ways. First, we assessed the impact on the regression coefficients reported in table 3 by computing

TABLE 4
Regression of Ratio Analysis Task Score (TASK 2) on General Experience, General Domain Knowledge, Subspecialty Knowledge, and Problem-Solving Ability for 239 Auditors

Variable	Beta	*T*-Statistic	Significance
PSTOT	.359	6.19	.000
AUDAPS	.321	5.70	.000
RAEVAL	.121	2.11	.036
MFG	.092	1.63	.104
MOEXP	.003	0.04	.965
CONSTANT		−4.41	.000

Adjusted $R^2 = .26$.
For independent variable names and definitions, see table 7.

TABLE 5
Regression of Manipulation of Earnings Task Score (TASK 3) on General Experience, World Knowledge, and Problem-Solving Ability for 239 Auditors

Variable	Beta	*T*-Statistic	Significance
GB	.468	7.86	.000
PSTOT	.092	1.57	.117
MANIP	.053	0.96	.341
MOEXP	.054	0.90	.369
CONSTANT		−1.34	.182

Adjusted $R^2 = .26$.
For independent variable names and definitions, see table 7.

the variance inflation factors (Neter, Wasserman, and Kutner [1985]).[4] This analysis suggested that multicollinearity was not a problem. Second, we controlled for general experience by regressing task performance on knowledge and ability variables within each subgroup of participants. The results were virtually identical to the results of the full-sample regressions.

Finally, we analyzed the student data in a similar fashion. The regressions reported in table 8 include only the knowledge and ability variables as well as the two self-evaluation variables since none of the students had public accounting experience. The results with students only partially support our hypotheses. One of the two general domain knowledge variables for internal control knowledge was significant for the internal control task; no measure of subspecialty knowledge was available. For the ratio task, most students performed very poorly, so that there were

[4] The variance inflation factor (*VIF*) measures how much the variances of the estimated regression coefficients are inflated because of multicollinearity. For each of the four regressions, we ran separate regressions of each independent variable on all the remaining independent variables. For each of these separate regressions, the *VIF* is computed as $(1 - R^2)^{-1}$. The $VIF = 1.0$ if there is no linear relationship among independent variables and is unbounded in the presence of perfectly linear relationships. With our data, the largest *VIF* was 1.17, well below the criterion value of 10.0 suggested by Neter et al. [1985] for indicating severe multicollinearity.

TABLE 6

Regression of Interest-Rate Swap Task Score (TASK 4) on General Experience and Subspecialty Knowledge for 239 Auditors

Variable	Beta	*T*-Statistic	Significance
IRS	.508	9.71	.000
FI	.218	4.25	.000
MOEXP	.172	3.37	.000
FIN	.108	2.07	.040
CONSTANT		−2.34	.018

Adjusted $R^2 = .46$.
For independent variable names and definitions, see table 7.

no significant variables; the variable closest to significance was problem-solving ability. The results of the third task are identical to those for auditors, with general business knowledge being the only significant variable. Finally, there were no significant variables for the interest-rate swap task, again because performance was very poor. This is reasonable since, for auditors, direct experience with swaps provides the best explanation of performance and none of the students had this experience.

5. Discussion

Most prior research of auditor expertise began by designating groups of experts and novices on the basis of general or task-specific experience; it then compared subject groups with respect to performance and/or cognitive dimensions such as knowledge content or knowledge organization. Although some studies have identified experience-related differences, on average, there were individuals identified as novices who performed like or had the knowledge of experts and vice versa. In this study, we departed from prior research in three ways. First, we identified experts and novices by their performance on four audit tasks. Second, we attempted to explain the level of performance by using more complete measures of task-specific experience and training and more direct measures of knowledge than those used in previous research. Third, we considered the effects of innate ability on performance.

Our results show that more experienced auditors, on average, did better in the tasks and had more knowledge and ability; however, the general experience variable explained less than 10% of the variance in performance scores. Instead, most of the explanatory power was provided by variables which reflected task-specific training and experience and innate ability. Given the variety of factors posited by previous research to have an effect on auditor performance, the proportion of variance explained by a relatively small set of independent variables for three of the four tasks seems to be substantive. These results indicate that ability may be important for certain types of audit tasks, e.g., diagnostic tasks which involve forward and backward reasoning; this result has not been dem-

TABLE 7

Correlation Matrix of Dependent and Independent Variables

	TASK 1	TASK 2	TASK 3	TASK 4	FI	GB	AUDCTL	AUDAPS	PSTOT	MOEXP	MFG	FIN	IRS	MANIP	ICEVAL	RAEVAL
TASK 1	1.000	.031	.077	.081	.009	.113	.042	.080	−.048	.143	.124	−.179	.129	.018	.109	.145
TASK 2		1.000	.108	.147	.141	.201	.040	.359	.377	.105	.068	−.053	−.016	−.044	.095	.147
TASK 3			1.000	.084	.194	.509	.034	.088	.214	.230	−.048	−.099	.059	.078	.187	.105
TASK 4				1.000	.366	.318	.061	.043	.167	.263	−.220	.313	.594	.059	.028	.211
FI					1.000	.326	−.002	.051	.218	.296	−.161	.082	.156	.122	−.014	.097
GB						1.000	.099	.188	.229	.321	−.029	.007	.125	.038	.113	.239
AUDCTL							1.000	.115	.006	.105	−.002	.035	−.042	.045	.012	.023
AUDAPS								1.000	.070	−.019	.055	.078	.048	.040	.083	.065
PSTOT									1.000	.247	−.096	.018	.067	.036	.043	.027
MOEXP										1.000	−.051	−.052	.043	.057	.170	.201
MFG											1.000	−.429	−.230	−.002	−.072	−.056
FIN												1.000	.385	−.074	.072	.049
IRS													1.000	.121	.048	.148
MANIP														1.000	−.126	.005
ICEVAL															1.000	.243
RAEVAL																1.000

TASK 1 = Internal controls
TASK 2 = Ratio analysis
TASK 3 = Manipulation of earnings
TASK 4 = Interest-rate swap
FI = Financial instruments knowledge
GB = General business knowledge
AUDCTL = Audit knowledge—controls
AUDAPS = Audit knowledge—analytical
PSTOT = Problem-solving ability
MOEXP = Months of audit experience
MFG = Percentage of time spent on manufacturing clients
FIN = Percentage of time spent on financial institution clients
IRS = Experience/training on interest-rate swaps
MANIP = Experience/training on client manipulations
ICEVAL = Self-rated ability at internal control evaluation
RAEVAL = Self-rated ability at ratio analysis

TABLE 8

*Regressions of Task Performance on Knowledge and Ability Variables for 30 Auditing Students**

Variable	*TASK 1*	*TASK 2*	*TASK 3*	*TASK 4*
AUDCTL	.181			
ICEVAL	.049			
AUDAPS		.604		
RAEVAL		.751		
PSTOT		.156	.526	
GB			.003	
FI				.833
Adjusted R^2	.10	.04	.24	−.03

* Numbers in this table represent significance levels for variables in four regressions of task performance on knowledge and ability variables.

onstrated previously. Further, very specific measures of knowledge or task-specific experience and training often provided the best explanations of expertise; for example, the best explanation of variation in performance in the interest-rate swap task was having clients who engaged in these swaps. Our results reflect the importance of task analysis which leads to the choice of multiple measures of task-specific experience and/or knowledge.

One of the limitations in this research is our use of many different types of task-specific experience and knowledge variables (such as scores on tests, factual questions about experience, and feelings of competence) that probably captured knowledge content to varying extents. Better task-specific experience and/or knowledge measures clearly could be developed. Problems with these measures could explain the lack of certain hypothesized effects. Second, our design did not allow us to capture fully the causal links among experience, ability, knowledge, and performance. Third, we examined only the effects of ability and knowledge content on performance; performance is probably affected by knowledge organization, strategies, motivation, effort, etc.

A final question raised by this paper relates to delineation of experts and novices in future studies of expert auditor judgment. The delineation will depend in part on the research question being addressed and the type of task being studied. If the research question relates to performance differences, then expertise should be measured by knowledge and ability variables. Whether innate ability should be included will depend on the characteristics of the task, as discussed above. If the research question relates to cognitive differences such as differences in strategies, expertise should be measured by performance. We believe that, at a minimum, future research must delineate expertise on the basis of *very specific* training, experience, and ability variables or proxies for those variables in the form of knowledge or aptitude test scores. For example, SAT scores could proxy for certain types of abilities and CPA examination scores could proxy for certain types of general domain knowledge. Further, it would not be difficult to employ the sorts of knowledge tests we used in a given project; our project included four tasks and the knowledge tests for all those tasks. A project addressing a single audit task would not be heavily burdened by the addition of a knowledge test.

REFERENCES

ASHTON, A. H. "An Empirical Analysis of Expertise, Experience, and Error Frequency Knowledge in Auditing." Working paper, Duke University, 1989.

———, AND P. R. BROWN. "Descriptive Modeling of Auditors' Internal Control Judgments: Replication and Extension." *Journal of Accounting Research* (Spring 1980): 269–77.

BEDARD, J., AND S. BIGGS. "Processes of Pattern Recognition and Hypothesis Generation in Analytical Review." Working paper, University of Connecticut, 1989.

BONNER, S. E. "Experience Effects in Auditing: The Role of Task-Specific Knowledge." *The Accounting Review* (January 1990): 72–92.

BUTT, J. L. "Frequency Judgments in an Auditing-Related Task." *Journal of Accounting Research* (Autumn 1988): 315–30.

CARMICHAEL, D. R., AND J. J. WILLINGHAM. *Auditing Concepts and Methods.* New York: McGraw-Hill, 1989.

CECI, S. J., AND J. K. LIKER. "A Day at the Races: A Study of IQ, Expertise, and Cognitive Complexity." *Journal of Experimental Psychology: General* (July 1986): 255–66.

CHARNESS, N. "Components of Skill in Bridge." *Canadian Journal of Psychology* (March 1979): 1–16.

CHASE, W. G., AND H. A. SIMON. "The Mind's Eye in Chess." In *Visual Information Processing*, edited by W. G. Chase. New York: Academic Press, 1973.

CHI, M. T. H., R. GLASER, AND E. REES. "Expertise in Problem Solving." In *Advances in the Psychology of Human Intelligence*, vol. 1, edited by R. J. Steinberg. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1982.

CLANCEY, W. J. "Methodology for Building an Intelligent Tutoring System." In *Method and Tactics in Cognitive Science,* edited by W. Kintsch, J. R. Miller, and P. G. Polson. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1984.

COAKLEY, J. R., AND J. K. LOEBBECKE. "The Expectation of Accounting Errors in Medium-Sized Manufacturing Firms." *Advances in Accounting* (1985): 199–245.

DAVIS, J. S., AND I. SOLOMON. "Experience, Expertise and Expert-Performance Research in Public Accounting." *Journal of Accounting Literature* (Fall 1989): 150–64.

EINHORN, H. J. "Expert Judgment: Some Necessary Conditions and an Example." *Journal of Applied Psychology* (October 1974): 562–71.

ENGLE, R. W., AND L. BUKSTEL. "Memory Processes Among Bridge Players of Differing Expertise." *American Journal of Psychology* (December 1978): 673–89.

FREDERICK, D. M. "Auditors' Representation and Retrieval of Internal Control Knowledge." Working paper, University of Colorado at Boulder, 1989.

———, AND R. LIBBY. "Expertise and Auditors' Judgments of Conjunctive Events." *Journal of Accounting Research* (Autumn 1986): 270–90.

GUY, D. M., AND C. W. ALDERMAN. *Auditing.* New York: Harcourt Brace Jovanovich, 1987.

HALL, W. D. "What Does It Take to Be an Auditor? *Journal of Accountancy* (January 1988): 72–80.

HAMILTON, R. E., AND W. F. WRIGHT. "Internal Control Judgments and Effects of Experience: Replications and Extensions." *Journal of Accounting Research* (Autumn 1982, pt. II): 756–65.

HUNTER, J. F. "Cognitive Ability, Cognitive Aptitude, Job Knowledge, and Job Performance." *Journal of Vocational Behavior* (December 1986): 340–62.

JOSEPH, G. M., AND V. L. PATEL. "Specificity of Expertise in Clinical Reasoning." In *Proceedings of the Eighth Annual Conference of the Cognitive Science Society*. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1986.

KINNEY, W. R., JR., G. L. SALAMON, AND W. C. UECKER. *Computer Assisted Analytical Review System.* Sarasota, Fla.: American Accounting Assn., 1986.

LESGOLD, A. M. "Acquiring Expertise," In *Tutorials in Learning and Memory: Essays in Honor of Gordon Bower*, edited by J. R. Anderson and S. M. Kosslyn. New York: W. H. Freeman and Co., 1984.

LIBBY, R. "Experimental Research and the Distinctive Features of Accounting Settings." Paper presented at the University of Illinois Golden Jubilee Symposium, June 1989.

———, AND D. M. FREDERICK. "Expertise and the Ability to Explain Audit Findings." *Journal of Accounting Research* (Autumn 1990): 348–67.

MARCHANT, G. A. "Analogical Reasoning and Error Detection." Ph.D. dissertation, University of Michigan, 1987.

MESSIER, W. F., JR. "The Effect of Experience and Firm Type on Materiality/Disclosure Judgments." *Journal of Accounting Research* (Autumn 1983): 611–18.

MURPHY, A. H., AND R. L. WINKLER. "Can Weather Forecasters Formulate Reliable Probability Forecasts of Precipitation and Temperatures?" *National Weather Digest* (May 1977): 2–9.

NETER, J., W. WASSERMAN, AND M. H. KUTNER. *Applied Linear Statistical Models: Regression, Analysis of Variance, and Experimental Designs.* Homewood, Ill.: Richard D. Irwin, 1985.

OSKAMP, S. "Overconfidence in Case-Study Judgments." *Journal of Consulting Psychology* (June 1965): 261–65.

"Perspectives on Education: Capabilities for Success in the Accounting Profession." Report Prepared by a Committee of the Partners-in-Charge of the Big Eight Firms, 1989.

REITMAN, J. S. "Skilled Perception in Go: Deducing Memory Structures from Inter-Response Times." *Cognitive Psychology* (July 1976): 336–56.

SHANTEAU, J. "Psychological Characteristics and Strategies of Expert Decision Makers." *Acta Psychologica* (1988): 203–15.

SIMON, H. A. "Information Processing Models of Cognition." *Annual Review of Psychology* (1979): 363–96.

STAEL VON HOLSTEIN, C. A. S. "An Experiment in Probabilistic Weather Forecasting." *Journal of Applied Meteorology* (August 1971): 635–45.

VOSS, J. F., T. R. GREENE, T. A. POST, AND B. C. PENNER. "Problem-Solving Skill in the Social Sciences." In *Psychology of Learning and Motivation*, edited by G. Bower. New York: Academic Press, 1983.

WALKER, C. H. "Relative Importance of Domain Knowledge and Overall Aptitude on Acquisition of Domain-Related Information." *Cognition and Instruction* (1987): 25–42.

WEBER, R. "Some Characteristics of the Free Recall of Computer Controls on EDP Auditors." *Journal of Accounting Research* (Spring 1980): 214–41.

WRIGHT, W. F. "Audit Judgment Consensus and Experience." In *Behavioral Accounting Research: A Critical Analysis*, edited by K. R. Ferris. Columbus, Ohio: Century VII Publishing Co., 1988.